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(54) LIGHTWEIGHT CELLULAR CONCRETE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide lightweight cellular concrete and a method of manufactur ing the same which has ≥ 0.3 to <0.7 volumetric specific gravity, higher gas permeability than specific value, high strength, excellent surface smoothness, and high nail retention.

SOLUTION: The lightweight cellular concrete and the method of manufacturing the lightweight cellular concrete are that the max. diameter of bubbles ≥ 300 µm is practically null, the volumetric percentage of maximum diameter of bubbles from ≥ 50 µm, to ≤ 200 µm is ≥ 20 vol.% to ≤ 30 vol.%, and the volumetric percentage of max. diameter of bubbles from ≥ 200 µm to ≤ 300 µm is ≥ 2 vol.% to ≤ 15 vol.%, and its volumetric specific gravity is ≥ 0.3 to <0.7. The lightweight cellular concrete is manufactured by passing slurry added with a foaming agent through a foaming device in which the ceramic beads are filled.
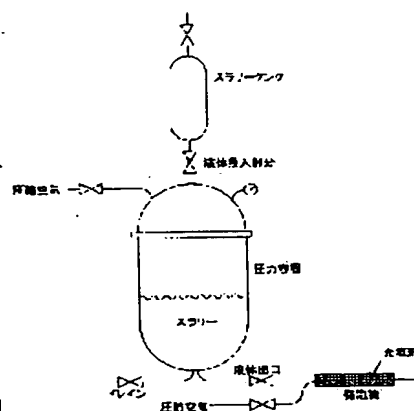
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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field belonging to invention] This invention relates to autoclaved lightweight concrete and its manufacture method.

[0002]

[Description of the Prior Art] It excels in refractoriness and adiathermic by nonflammable, the common autoclaved lightweight concrete (ALC) as lightweight building materials is lightweight, and since it has many features, such as excelling also in workability, it is widely used as building materials, such as a wall, a floor, a roof, and a partition. After introducing air bubbles into the slurry which used silica, Portland cement, calcined lime, etc. as the main raw material with a foaming agent, a frothing agent, etc. and stiffening it generally, autoclave curing of the autoclaved lightweight concrete is carried out, and it is manufactured. Thus, generally as for relative bulk density, the thing of the range of 4 - 5 N/m2 has [the manufactured autoclaved lightweight concrete] much compressive strength 0.5 to about 0.6. And a solid-state portion makes a subject a tobermorite crystal (5CaOand6SiO2.5H2O), a low crystallinity calcium silicate hydrate (it is henceforth described as CSH.), and residual silica. As a foaming agent of these autoclaved lightweight concrete, it is common to use metal aluminum.

[0003] It is common to, use a non-ion system, an ion system surfactant, etc. as a frothing agent on the other hand, and the method of mixing this with a slurry after the manufacture method carries out foam formation of the aqueous solution which mainly contains a frothing agent by churning etc. beforehand, and making air bubbles containing, the method of including air bubbles in a slurry at the time of a churning mixing activity with the aqueous solution and concrete material containing a frothing agent, etc. are mentioned. However, many of diameters of air bubbles obtained by these methods have many about 1mm big and rough things, and it has brought about the fall of the compressive strength of a hardening object, and flexural strength, and deterioration of surface smooth nature or ****** as a result.

[0004] As a method of improving to the high intensity of autoclaved lightweight concrete, the technology of manufacturing a light weight concrete with a light weight and high intensity, without using a frothing agent is indicated by JP,7-101787,A, and the technology of manufacturing gas concrete with a light weight and high intensity using a frothing agent is indicated at JP,8-12464,A. The building materials with which both official reports exceed compressive strength about 20 N/m2 are reported. However, the minimum attainment specific gravity is 0.7 to about 0.8, and is level still inadequate as a lightweight member.

[0005] On the other hand, it is reported to WO 99/42418 as examination which raises the plane smooth nature of autoclaved lightweight concrete in the or more 0.3 relative bulk density [or less 0.7] range that the outstanding plane smooth nature and the reinforcement which are not in conventional autoclaved lightweight concrete were obtained, without a path containing air bubbles 200 micrometers or more substantially. however -- although reinforcement and surface smooth nature are sharply improved when a path does not contain air bubbles 200 micrometers or more substantially (i.e., when air bubbles are not introduced) -- hardening -- the permeability of a gas in the living body becomes very low. the decline in gas permeability -- hardening -- it leads to control of diffusion of the water from the inside of the body, and a rate of drying when a

hardening object is damp becomes slow. Therefore, autoclaved lightweight concrete which has the high light weight and the high intensity of gas permeability, and plane smooth nature is desired.
[0006]
[Problem(s) to be Solved by the Invention] Less than [0.3 or more] by 0.7, having gas permeability more than fixed, relative bulk density is excellent in high intensity and surface smooth nature, and this invention has it in autoclaved lightweight concrete with still higher ******, and a list in those manufacture methods at offer ******.
[0007]
[A means to solve a technical problem] this invention persons came to complete a header and this invention for the ability of gaseous permeability to be raised, when the volume fraction of 200 micrometers or more of diameters of air bubbles and air bubbles 300 micrometers or less existed within fixed limits, maintaining high intensity and plane smooth nature wholeheartedly paying attention to the weight ratio of the water to a solid-state raw material and the amount of installation of air bubbles, and an introductory method as a result of research. Namely, this invention (1) There are no air bubbles exceeding the overall diameter of 300 micrometers substantially. And the volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%30vol%]. And the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%15vol%]. And the autoclaved lightweight concrete with which relative bulk density is characterized by or more 0.3 being less than 0.7, (2) (1) to which logarithmic distribution width of face in one fourth of the height of the maximum of the differential pore distribution measured with a method of mercury penetration is characterized by or more 0.4 being 1.2 or less, or autoclaved lightweight concrete given in (2), (3) The aqueous solution which contains the nature raw material of silicic acid, cement, a calcareous raw material, an aluminum sulfate or its hydrated compound, water, and a frothing agent at least After mixing so that the weight ratio of all the used water to the AUW of a solid-state raw material may become 2.5 or less [0.9 or more], and obtaining a slurry This slurry is processed in a cellular generator so that the unit capacity of the slurry which receives the unit capacity of the slurry which does not contain air bubbles after carrying out cellular content may become 1.35 or less times 1.1 or more times. the manufacture method of the autoclaved lightweight concrete characterized by carrying out autoclave curing after pouring in and carrying out precure of this cellular content slurry to a mold -- it comes out.
[0008] Hereafter, this invention is explained to details. The autoclaved lightweight concrete of this invention does not have substantially the air bubbles exceeding the overall diameter of 300 micrometers, the volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%30vol%], and the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%15vol%]. It is that 20 or less air bubbles [ten or less] with which an overall diameter exceeds 300 micrometers for 30mm around on the field which that there are no air bubbles exceeding the overall diameter here of 300 micrometers substantially made fracture the autoclaved lightweight concrete of this invention, and was produced are five or less pieces still more preferably preferably. If the air bubbles exceeding the overall diameter of 300 micrometers exist exceeding 20 pieces, surface smooth nature may fall and a fall on the strength may be caused further. With the conventional material, it has many big and rough air bubbles exceeding 1mm, and it is thought without such big and rough air bubbles that ****** leads to the improvement in on the strength.
[0009] The volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles of the autoclaved lightweight concrete of this invention is less than [more than 20vol%30vol%]. And it is required for the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles to be less than [more than

2vol%15vol%]. The volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%25vol%] preferably, and the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%10vol%].

[0010] Here, the volume fraction range of the overall diameter of the air bubbles indicated above that the volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%30vol%], and the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%15vol%] is filled, and it means that the volume fraction of with a 50-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 22vol%35vol%]. Here, it becomes possible to hold the gas permeability of a hardening object more than fixed, having surface smooth nature with high intensity as the volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%30vol%] and the volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%15vol%].

[0011] In this invention, the volume fraction of air bubbles is the value which computed area by having measured the diameter of air bubbles of all the air bubbles per unit area of the fracture surface of the autoclaved lightweight concrete of this invention, and having assumed that all air bubbles were circles from distribution of the diameter of air bubbles, and was computed from the ratio of a surface integral of the gross area of the circle to an unit area, i.e., the rate of air bubbles. Since the rate of a surface integral of air bubbles in the cross section of arbitration was in agreement with the volume fraction, it made the rate of a surface integral of the air bubbles computed here the volume fraction of air bubbles. With the diameter of air bubbles here, the overall diameter of each air bubbles on the fracture surface was measured (it is henceforth described as La), the overall diameter (it is henceforth described as Lb) of these vertical air bubbles was continuously measured to La, and it computed from the pitch diameter of these La and Lb. The diameter of these air bubbles printed the image observed by one 50 times the scale factor of this using the optical microscope, and measured it manually. On the occasion of measurement, the unit area was chosen so that the measurement number of counts of air bubbles might become 1000 or more pieces.

[0012] Moreover, air bubbles here mean the spherical opening generated with the frothing agent, and since a ball, an ellipsoid, water drop-like, or the configuration that these combined is usually made, it is easily distinguishable from the opening generated by the crack or the chip. The unescapable air bubbles which air mixed and were furthermore produced in the manufacture process are also included. The relative bulk density of the autoclaved lightweight concrete of this invention is in or more 0.3 less than 0.7 range, and is 0.6 or less [0.3 or more] preferably. Relative bulk density here points out the relative bulk density at the time of making it dry at 105 degrees C for 24 hours, i.e., specific gravity under oven dry. The high reinforcement made into the purpose of this invention is not obtained less than by 0.3. Conversely, it shifts from the criteria of the lightweight gas concrete made into the purpose of this invention or more in 0.7.

[0013] In the autoclaved lightweight concrete of this invention, it is desirable that the logarithmic distribution width of face in one fourth of the height of the maximum of the differential pore distribution measured with a method of mercury penetration is 1.2 or less [0.4 or more]. A method of mercury penetration makes mercury press fit inside a hardening object, measures distribution of pore size from the pressure at that time, and the relation of the amount of invasion, and it is calculated by the configuration of pore assuming it to be a cylindrical shape here. Therefore, although the range of the measurable range of pore size is 6nm - 360 micrometers, in case this value does not express the diameter of actual pore, is used as an index of the magnitude of the crevice between constituents and describes the pore structure of the specific gravity range of this invention especially, it is an effective analysis means. The differential pore distribution measured with the method of mercury penetration differentiates the

cumulative curve of the amount of pores to the measured pore size primarily, and is acquired. Usually, the opening of the portion (it is henceforth described as a matrix) which forms the frame of the low autoclaved lightweight concrete of or more 0.3 less than 0.7 relative bulk density exists between 6nm - 50 micrometers of pore size in the measuring range.
[0014] The logarithmic distribution width of face in the height of the maximums 1/4 of differential pore distribution is one index of expressing the breadth of pore volume distribution, and the width of face of the pore volume distribution in one fourth of the height of the maximum of differential pore distribution is displayed in a logarithm. The calculation method is shown in drawing 1 (A) and (B). When the logarithmic distribution width of face in one fourth of the height of maximum exceeds 1.2, the diameter of an opening will have distribution with the large pore volume distribution in a pore field 50 micrometers or less, and it is shown that the homogeneity of the opening of the matrix which bears this, i.e., stress, is low. Therefore, there is orientation to become easy to produce local stress concentration and to bring about the fall of compressive   strength.
[0015] For example, the opening which exists in the matrix which forms the portion except the big and rough air-bubbles section into which conventional autoclaved lightweight concrete was introduced with the foaming agent or the frothing agent, i.e., a frame, had large distribution, and the logarithmic distribution width of face in one fourth of the height of the maximum of the differential pore distribution measured with the method of mercury penetration is over 1.2. That is, this invention persons are surmising that it is desirable for it improving physical properties, such as reinforcement, that an opening with the large distribution which exists in these pore field carries out to 1.2 or less by the logarithmic distribution width of face in one fourth of the height of the maximum of the differential pore distribution measured with the method of mercury penetration.
[0016] In this invention, although the one of other physical properties [on the strength and] where this logarithmic distribution width of face is smaller improves, even if it carries out with the manufacture method of this invention, it is difficult to obtain logarithmic distribution width of face smaller than 0.4. Therefore, it is desirable that the logarithmic distribution width of face in one fourth of the height of the maximum of the micropore distribution measured with a method of mercury penetration is 1.2 or less [0.4 or more]. It is 1.0 or less [0.4 or more] especially preferably 1.1 or less [0.4 or more] still more preferably. In the autoclaved lightweight concrete of this invention, it is desirable that tobermorite is a subject.
[0017] During the organization of conventional autoclaved lightweight concrete etc., tobermorite is one of the typical crystalline calcium silicate hydrates usually seen, and takes tabular or the strip-of-paper-like shape of particle. In the autoclaved lightweight concrete of this invention, it judges whether tobermorite is a subject by using together scanning electron microscope observation of the fracture surface and powder X-ray observation of a calcium silicate hardening object.
[0018] That is, in a powder X diffraction, it is that other diffraction peaks exceeding the strongest line (220) of tobermorite do not exist. However, when a crystalline substance silica, a calcium carbonate, and gypsum fibrosum live together with tobermorite, although the strongest line of such material may exceed the strongest line of tobermorite for crystallinity with the high quality of these concomitants even if tobermorite is a subject, suppose that tobermorite will be a subject in such a case if it can judge that the structure is tabular under scan mold microscope observation, or a strip-of-paper-like particle is a subject. here -- the particle of the shape of tabular or a strip of paper -- one particle -- setting -- mutual -- a cheek -- the distance between the two parallel surfaces is equivalent to the minimum length of the particle, and it considers as the particle whose maximum length of the particle is 5 or more times of minimum length (it is henceforth described as thickness). Of course, length between couplings here and thickness are two dimensions in projection length. Although the magnitude of the particle of these tobermorites does not carry out especially a convention, it is desirable that the maximum length

is several micrometers - 10 micrometers.

[0019] Usually, tobermorite coexists with CSH in many cases. Although taking various shape of particle is known, CSH is usually distinguishable from a tobermorite particle under an electron microscope, in order to take fibrous and the granular and massive shape of particle. Here, since CSH reduces various requirements as building materials, such as reinforcement, weatherability, and endurance, not containing as much as possible is desirable. Furthermore, in the autoclaved lightweight concrete of this invention, a small amount of lightweight aggregate, reinforcement fiber, resin, etc. can be contained in the range which does not break down the basic frame of tobermorite.

[0020] As for the autoclaved lightweight concrete of this invention, it is desirable that the ratio (Ia/Ib) of the diffraction (220) peak intensity Ib of the tobermorite to the diffraction line (220) of two tobermorites and the minimum value Ia of the diffraction reinforcement in the angle field inserted into (022) which are observed in a powder X diffraction is 4.0 or more. If CSH exists so much in a light weight concrete, various properties as building materials will deteriorate. About the hardening object with which tobermorite and CSH live together, if a powder X diffraction is performed, the diffraction peak of broadcloth CSH will be accepted in the field inserted into the diffraction (220) peak and diffraction (222) peak of tobermorite. This diffraction peak usually appears near 29.1-29.4 degree (2theta). Moreover, compared with tobermorite, CSH becomes the form where the peak of CSH was absorbed by the diffraction line of tobermorite when few, and, as for measurement of the diffraction reinforcement of CSH, usually becomes impossible.

[0021] However, when such, since the diffraction reinforcement of the X-ray in the field inserted into the diffraction (220) peak and diffraction (222) peak of tobermorite serves as a high value compared with the base line, it can judge the existence of the existence of CSH. When autoclaved lightweight concrete does not contain CSH at all and it makes tobermorite of high crystallinity into a subject, the minimum value of the X-ray intensity in this field is in agreement with background reinforcement. That is, there is so little CSH contained in autoclaved lightweight concrete that the ratio (Ib/Ia) of the diffraction line of two tobermorites and the diffraction peak intensity Ib of the field (220) of the tobermorite to the minimum value Ia of the diffraction reinforcement in the angle field inserted into (220) and (222) is large.

[0022] On the other hand, Ib/Ia becomes small, when CSH does not exist even if and the crystallinity of tobermorite is low. Since (220) and (222) are close, this is because those of the skirt of a peak overlaps. If the crystallinity of tobermorite falls, deterioration of a light weight concrete on the strength and a weatherproof fall will take place. Therefore, in any case, the value of Ib/Ia is 4.5 or more still more preferably [4.0 or more are desirable still more desirable and] than 4.2 or more and it. When the reactant low source of silica is used for commercial autoclaved lightweight concrete, the crystallinity of tobermorite is raised and the value of Ib/Ia is high as a result. Although this value is high, the reason nil why reinforcement is low is because big and rough air bubbles 1mm or more are contained so much. The outline of the calculation method of Ia and Ib is shown in drawing 2 (A) and (B).

[0023] In gas permeability measurement, more than 0.11m4/sec-kg, a certain thing is desirable still more desirable, and the autoclaved lightweight concrete of this invention is more than 0.12m4/sec-kg. gas permeability -- hardening, so that the ease of carrying out of transparency of a gas in the living body is shown and the value of gas permeability becomes large -- a gas -- hardening -- it is easy to penetrate the inside of the body. hardening -- the degree of transparency of a gas in the living body -- hardening -- it is thought that it becomes the index of the degree of diffusion of the water contained inside of the body. namely, -- if gas permeability is low -- hardening -- when it leads to control of diffusion of the water from the inside of the body and a hardening object is damp, a rate of drying becomes slow. Therefore, if [fixed] there is gas permeability at all in the autoclaved lightweight concrete of this invention, a certain direction is desirable.

[0024] Hereafter, the manufacture method of the autoclaved lightweight concrete of this

invention is explained. The manufacture method of the autoclaved lightweight concrete of this invention needs to mix the aqueous solution which contains the nature raw material of silicic acid, cement, a calcareous raw material, an aluminum sulfate or its hydrated compound, water, and a frothing agent at least so that the weight ratio of all the used water to the AUW of a solid-state raw material may become [the weight ratio of all the used water to the AUW of a solid-state raw material] desirable to 2.5 or less [0.9 or more] 2.5 or less [1.0 or more], and to obtain a slurry. In addition, the weight of water of crystallization is also included in the weight of all the water that did not include the weight of water of crystallization but was used for the AUW of a solid-state raw material in this invention.

[0025] The nature raw materials of silicic acid are the silica of a crystalline substance, silica sand and noncrystalline diatomaceous earth, silica fume, fly ash, natural clay minerals, those baking objects, etc. here. In order to attain the target high intensity, as for the autoclaved lightweight concrete of this invention, it is desirable to use crystalline silica, in Blaine's specific surface area pulverized especially, its fines silica more than 5000cm2/g is desirable, and it is fines silica more than 7000cm2/g more preferably. The addition of the nature raw material of silicic acid is 30 or less % of the weight 5 % of the weight or more to the solid-state raw material at the time of manufacturing the autoclaved lightweight concrete of this invention, and is 25 or less % of the weight 10 % of the weight or more preferably.

[0026] Moreover, cement says the cement which makes a subject a silicic acid component and calcium components, such as ordinary portland cement, high-early-strength Portland cement, and belite cement. Furthermore, a calcareous raw material is a raw material which contains CaO 50% of the weight or more by oxide conversion, and a limestone or slaked lime is said. A calcareous addition is 20 or less % of the weight 2 % of the weight or more to the solid-state raw material at the time of manufacturing the autoclaved lightweight concrete of this invention, and is 15 or less % of the weight 2 % of the weight or more preferably.

[0027] In this invention, by using an aluminum sulfate or its hydrated compound, it becomes possible to raise water / solid-state ratio, and, as a result, the amount of cellular installation controls to arbitration the specific gravity obtained at least, and the diameter of air bubbles can be freely controlled now. The addition of the aluminum sulfate or its hydrated compound It is 10 or less % of the weight 0.09 % of the weight or more with (aluminum 2O3) in oxide conversion to a solid-state raw material. When the weight ratio (it is henceforth described as water / solid-state ratio) of the used water to the AUW of the solid-state raw material to be used is less than 0.95 When it is desirable that it is [0.09 % of the weight or more] 3 % of the weight, it is 2 or less % of the weight 0.12 % of the weight or more more preferably and water / solid-state ratio is less than [0.95 or more] 1.9 It is preferably desirable that it is [0.15 % of the weight or more] 10 or less % of the weight 0.2 % of the weight or more when it is 6 or less % of the weight and water / solid-state ratio is 1.9 or more. Amount of water here means a thing including all the water contained in the aqueous solution containing water, water of crystallization, and a frothing agent.

[0028] Moreover, an aluminum sulfate or the aluminum sulfate in the hydrated compound means the material which consists of a chemical formula (aluminum2(SO4) 3), and the hydrated compound means the compound containing water of crystallization as shown with a chemical formula (aluminum2(SO4) 3.17H2O). as a raw material gestalt -- powder, a slurry, and an aqueous solution -- any are sufficient. As an aqueous solution containing a frothing agent, if air bubbles are generated, the frothing agent of common knowledge of arbitration can be used. For example Marl P (product made from Aso Foamcrete) etc. as a frothing agent of an animal protein system as a surfactant The sodium oleate of an anion system surfactant, tetrapropylene benzenesulfonic acid sodium, The ethyleneoxide addition product of the octyl phenol of a non-ion system surfactant, such as sodium dioctyl sulfosuccinate, The ethyleneoxide addition product of higher alcohol, lauryl acid diethanolamide, etc., The formate of the triethanolamine MONOSUA rate of a cation system surfactant, The acetate of stearamide ethyl diethylamine,

lauryl trimethylammonium chloride, The lauryl aminopropionic acid sodium of amphoteric surface active agents, such as SUTEARAMIDO methyl pyridinium chloride, a lauryldimethyl betaine, a lauryl dihydroxyethyl betaine, etc. are mentioned, and neither ionicity nor structure is limited.

[0029] Although the addition of the aqueous solution containing a frothing agent is not especially specified, if reverse has too many frothing agents, therefore it will be hard to obtain air bubbles in a slurry if there are few amounts of a frothing agent, and the viscosity of a slurry will increase and it will be hard to obtain air bubbles, 50 % of the weight 0.05 % of the weight or more is 45 % of the weight 0.1 % of the weight or more desirable still more preferably to the weight of the water in a slurry. About mixing, the mixer of arbitration is usable. The frothing agent used for this invention is a frothing agent which introduces air bubbles using a surfactant as shown above etc. unlike the foaming agent by the metal aluminum currently generally used with autoclaved lightweight concrete.

[0030] Although there is especially no convention about the temperature which mixes the slurry which consists of a solid-state raw material and water, if a mixed temperature is too low, a reaction cannot progress easily. Therefore, at the temperature immediately after mixing, 40 degrees C or more and 100 degrees C or less are desirable, and is 50 degrees C or more 100 degrees C or less more preferably. Moreover, although there is especially no convention also in the time amount which mixes a slurry, since the hydration of cement will advance too much if too long [if too short, homogeneity distribution of each solid-state raw material is inadequate, and], precure will be delayed. Therefore, 10 minutes or more, less than 5 hours is desirable and is less than 3 hours 30 minutes or more more preferably.

[0031] In introducing air bubbles, in the manufacture method of this invention, it is required to process in a cellular generator so that the unit capacity of the slurry which receives the unit capacity of the slurry which does not contain air bubbles after carrying out cellular content may become 1.35 or less times 1.1 or more times. This is an indispensable condition there being no air bubbles exceeding 300 micrometers which are the purposes of this invention substantially, and the volume fraction of 200 micrometers or more of diameters of air bubbles and air bubbles 300 micrometers or less making it exist within fixed limits, and attaining plane smooth nature, high intensity, and the gas permeability more than fixed. When the unit capacity of the slurry after making the gas to the unit capacity of the slurry which does not contain air bubbles contain exceeds 1.35 times, it becomes difficult for coalescence and foam breaking of air bubbles to happen and to obtain homogeneity and detailed air bubbles, and surface smooth nature is made to fall further. Moreover, by less than 1.1 times, the gas permeability more than fixed is not obtained for the unit capacity of the slurry after making the gas to the unit capacity of the slurry which does not contain air bubbles contain.

[0032] Therefore, it is 1.30 or less [1.20 or more] or less [1.15 or more] to 1.30 to introduce air bubbles so that the unit capacity of the slurry which receives the unit capacity of the slurry which does not contain air bubbles by the manufacture method of the autoclaved lightweight concrete of this invention after carrying out cellular content may become 1.35 or less times 1.10 or more times still more preferably [it is desirable still more desirable and]. In this invention, the slurry which does not contain air bubbles adds the total solid-state raw material and water, is mixed, and means the slurry which does not contain the air bubbles which added and obtained the aqueous solution which contains a frothing agent further.

[0033] In this invention, the equipment which usually adds the aqueous solution containing a frothing agent as indicated to be a cellular generator to drawing 3 etc., and produces foam is said, and what mainly consists of a part for a part for a liquid injection portion and the foaming cylinder part to which the bulking agent of a liquid outlet, its bead connected previously was carried out, and a compressed-air feed zone, and a pressure vessel portion to which they were connected is said. As for a part for a compressed-air feed zone, what can change the air pressure to supply is desirable. In this invention, although especially a rule does not have the bulking

agent packed in a foaming cylinder about a material and a configuration, air bubbles, such as a ceramic bead, a glass bead, and a metal scrubbing brush, have homogeneity and the desirable thing which becomes detailed. Moreover, actuation of making the slurry containing a frothing agent passing or piling up the same with throwing in the aqueous solution which usually contains a frothing agent in a cellular generator as processing in a cellular generator, and producing foam is said.

[0034] The slurry containing the air bubbles for autoclaved-lightweight-concrete manufacture of this invention can be obtained by performing actuation of making the inside of this cellular generator the slurry which threw in the frothing agent pass or pile up. Although there is especially no limitation here when the length of a foaming cylinder manufactures the autoclaved lightweight concrete of this invention, 25cm or more 150cm or less is desirable. Furthermore, although there is especially no limitation when the pressure of the compressed air manufactures the autoclaved lightweight concrete of this invention, 0.001 or more-MPa 0.15 or less MPa is desirable.

[0035] Thus, the obtained cellular content slurry is preferably slushed into a mold as it is, and is fabricated. Precure of the acquired Plastic solid is preferably carried out over 1 hours or more below 40 degrees C or more 100 degrees C. Cutting process with the wire generally used to manufacture of autoclaved lightweight concrete can also use cutting of the acquired precure object. After being cut by the configuration of arbitration if needed, an autoclave is used and an elevated-temperature high-pressure regimen is carried out. As conditions for an autoclave, below 220 degrees C (gage pressure: about 2.3 MPa(s)) are desirable more than 160 degree C (gage pressure: about 0.54 MPa(s)). The acquired hardening object is dried and the autoclaved lightweight concrete of this invention is obtained.

[0036] [Embodiment of the Invention] Although an example explains this invention concretely below, this invention is not limited to these. In addition, various kinds of measuring methods used in this invention are as follows.

[Flexural strength, compressive strength] JIS R It measured according to measurement of the bending strength of 5201, and compressive strength. That is, the specimen size used for flexural strength measurement is 40mmx40mmx160mm, and span width of face is 100mm. Compressive strength measured maximum load in the sample of the one half which broke in the bending test as structure where vertical both the compression side becomes parallel by pressurization side 40mmx40mm. In addition, in 20 degrees C and the oven of 60% of relative humidity, it was made to dry until the moisture content on the basis of the absolute dry condition of a hardening object became $10^{**}2\%$ of the weight, and the specimen measured. After it made the sample fracture surface after measurement of the diameter of air bubbles, and a [volume fraction] bending test carry out impregnation of the epoxy resin adhesive and epoxy resin adhesive hardened, the surface was ground by sand paper and the sample surface was observed using the KEYENCE CORP. make and digital HD microscope VH-7000. It computed area by the area of the diameter of air bubbles having measured the overall diameter (La) of air bubbles, having measured the overall diameter (Lb) of these vertical air bubbles to La, and having approximated the pitch diameter of La and Lb with the diameter of circle.

[0037] [powder X diffraction: After grinding in a mortar the sample used for measurement] on-the-strength measurement of Ia and Ib, in RINT2000 made from Physical science Electrical and electric equipment, it measured using K alpha rays of Cu. A Measuring condition is 40kV in acceleration voltage, and acceleration current is 200mA, light-receiving slit width [of 0.15mm], and scan speed part [for /] and sampling 0.02degree. [of 4 degrees] in addition, a diffraction line -- the monochromator of graphite -- monochrome -- it-izing and counted. The maximum reinforcement of two tobermorite diffraction lines (220) and the tobermorite diffraction line (220) which includes Ia and a background for the minimum value of diffraction reinforcement including the background in the angle field inserted into (222) is set to Ib. In addition, these two

diffraction lines are equivalent to the diffraction line seen 29.0 degrees and near 30.0 degree (2theta), respectively. The mimetic diagram of the calculation method is shown in drawing 1 (A) and (B).

[0038] After pulverizing the hardening object after [calculation of logarithmic distribution width-of-face [by the method of mercury penetration], and amount rate of pores] autoclave, it was made to dry at 105 degrees C for 24 hours, and 2 classified and obtained - 4mm portion were made into the test sample. About these samples, they are a product made from Micrometritics, and Pore. Sizer Pore volume distribution was measured using 9320. In the contact angle of mercury and a hardening object, at this time, the surface tension of mercury calculated as 484 dyn/cm 130 degrees. if [when the number of the pore size which gives one fourth of the height of the maximum of the differential pore distribution which differentiates the primary cumulative curve of the amount of pores to the measured pore size, and is acquired is two / descending] A1 and A2 -- logarithmic distribution width of face -- A1 and A2 -- it becomes the difference of each common logarithm. The calculation method in case the number of the pore size which gives one fourth of the height of the maximum of differential pore distribution is two is shown in drawing 2 (A) and (B). When there is much two pore size which gives one fourth of the height of the maximum of differential pore distribution, it becomes the common logarithm of the pore size which gives maximum, and the difference of the common logarithm of the pore size which gives the minimum value.

It computed from the weight and the size when drying the hardening object after the autoclave of the same size as what was used for [relative-bulk-density] bending test at 105 degrees C for 24 hours.

[0039] ** and irregularity evaluated a certain condition for the condition that observation understands a [surface smooth nature] surface state visually, and O and irregularity understand the condition that there is almost no irregularity by x considerably. It was missing and expressed by O which cuts a hardening object using the saw for [saw length trial] woodwork, and can cut the ease of cutting easily, ** which is missing for a while, and x which cannot be cut. Moreover, ** and irregularity evaluated a certain condition for the condition that O and irregularity understand the condition that there is almost no irregularity about the condition of a cutting plane by x considerably. After making a prepared hole (a 3.0mm depth of 25mm of diameters) with a drill in the center of a [****** trial] 50mmx180mmx180mm specimen, drawing measurement was manually carried out for the Sara wood screw (path 4.1phi, a length of 45mm, product made from the Yawata screw thread 4-020-04145) using the bell and spigot and the **** type adhesion force testing machine to a depth of 30mm. In addition, in 20 degrees C and the oven of 60% of relative humidity, it was made to dry until the moisture content on the basis of the absolute dry condition of a hardening object became 10**2%, and the specimen measured. ****** is judged by the existence of cone destruction. When ****** of a nail and a hardening object is high and a nail is drawn out, the cone destruction which can take some hardening objects adhering to a nail to coincidence takes place, and if ****** is low, the nail omission phenomenon from which only a nail escapes will happen.

[0040] Gas permeability measurement was performed by phi50mm and the specimen with a height of 50mm using [gas permeability] Oriental Energy Machine Factory PERMEAGRAPH. After making the [rate-of-drying] 40mmx40mmx160mm specimen flooded underwater for 40 hours or more and carrying out saturation of the specimen, the moisture content on the basis of the absolute dry condition of a hardening object measured the drying time until it becomes 20**2% in 60 degrees C and the oven of conditions of 40% of relative humidity.

[0041]

[Examples 1-2] With the raw material compounding ratio shown in a table 1, it mixed using the agitator. Mixing was performed with atmospheric pressure for 2 hours, warming a mixing chamber at 60 degrees C, after adding a solid-state raw material to the water warmed at 60

degrees C. The rotational frequency of an agitator was 1200rpm. In addition, about the injection of a calcareous raw material, it supplied by dividing into two steps at a rate (primary injection: secondary injection) as shown in a table 1. namely, -- in addition, they are the primary injection added since it begins like a raw material, and the secondary injection added after performing churning with atmospheric pressure for 2 hours. Mixing was performed for 1 minute on the same conditions after the secondary calcareous raw material injection. It is the aqueous solution (Marl P and 35.0% of hydrolysis proteins) of the frothing agent for cement system materials to the slurry after mixing. In addition, the slurry which contains a frothing agent several seconds is agitated several seconds to the weight of all the water of the aqueous solution which contains the inside of the above-mentioned slurry, and a frothing agent for 0.6% of ash content, 64.6% of moisture, and Aso foamcrete company make about 1% of the weight. Supply this frothing agent content slurry in a cellular generator (cel form technical Kenkyusha make), and aeration is adjusted on the operating instructions same with usually producing air bubbles under the conditions of air pressure 0.025MPa and liquid-sending pressure 0.025MPa. Air bubbles were introduced so that the unit capacity of the slurry which receives the unit capacity of the slurry which does not contain air bubbles after carrying out cellular content might increase about 1.25 times.

[0042] A cellular content slurry is slushed into a mold after that, at 60 degrees C, it held for 5 hours and precure was carried out. It dried, after it unmolded these and the autoclave performed the elevated-temperature high-pressure regimen at 180 degrees C for 4 hours, and autoclaved lightweight concrete was obtained. moreover -- as the nature raw material of silicic acid shown in a table 1 -- a silica pulverized powder -- ordinary portland cement was used as a calcareous raw material, and cement used gypsum dihydrate for calcined lime as a sulfuric-acid compound. The weight section in a table 1 was written by the pure part which does not contain the used water. the various physical properties of these profit **** autoclaved lightweight concrete were performed. The result is shown in a table 2.

[0043] the volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete -- 50-200 micrometers -- 22 - 25vol% and 200-300 micrometers -- 6 - 7vol% -- it was. Also in which hardening object, the strongest line was identified the diffraction (220) line of tobermorite as a result of the powder X diffraction. In the example 1, in 3.7 N/m2 and the example 2, flexural strength was 4.6 N/m2 and compressive strength was 9.8 N/m2 and 18.5 N/m2, respectively. The result of having performed the ****** trial was cone destruction. The gas permeability test result was 0.17m4/sec-kg in 0.12m4/sec-kg and the example 2 in the example 1. As for the drying test result, by the time the moisture content on the basis of the absolute dry condition of a hardening object became 20**2%, it took 35 to 40 hours. [0044]

[The examples 1 and 2 of a comparison] With the compounding ratio shown in a table 1, except not adding the aqueous solution containing a frothing agent, the light weight concrete was produced by the same method as examples 1 and 2, and various physical-properties measurement was performed. The result is shown in a table 2. Specific gravity under oven dry was 0.45 and 0.70, respectively. The examples 1 and 2 of a comparison of the volume fraction of the diameter of the maximum air bubbles to a light weight concrete were less than [1vol%] in less than [1vol%] and 200-300 micrometers at 50-200 micrometers. Also in which hardening object, the strongest line was identified the diffraction (220) line of tobermorite as a result of the powder X diffraction. Gas permeability test results are 0.10m4/sec-kg and 0.09m4/sec-kg, respectively, and are low values compared with examples 1 and 2. The drying test result took 75 hours for 85 hours, respectively, by the time the moisture content on the basis of the absolute dry condition of a hardening object became 20**2%, and compared with examples 1 and 2, the drying time increased   it.
[0045]
[The example 3 of a comparison] Using the frothing agent, except having introduced air bubbles

so that the unit capacity of the slurry which receives the unit capacity of the slurry which does not contain air bubbles after carrying out cellular content might increase about 1.8 times, it was the same combination as an example 1, and the light weight concrete was produced by the same method, and various physical-properties measurement was performed. The result is shown in a table 2. Specific gravity under oven dry was 0.31. The volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete was 21vol(s)% in 200-300 micrometers 9.5vol(s)% at 50-200 micrometers. The strongest line was identified the diffraction (220) line of tobermorite as a result of the powder X diffraction. It was a nail omission as a result of performing a ****** trial. The gas permeability test result was 0.21m4/sec-kg. The moisture content on the basis of the absolute dry condition of a hardening object took 40 hours, by the time the drying test result became 20**2%, and it was almost the same as that of an example 1. [of   it   ]

[0046]
[The example 4 of a comparison] The non-muscle portion was extracted from commercial ALC, and various physical-properties measurement was performed. The result is shown in a table 2. Specific gravity under oven dry was 0.51. The volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete was 1.7vol(s)% in 200-300 micrometers 0.26vol(s)% at 50-200 micrometers. Only the diffraction (101) line of a quartz was observed as a peak higher than the diffraction (220) line of tobermorite as a result of the powder X diffraction. Flexural strength was 1.4 N/m2, and compressive strength was 5.0 N/m2 and was a value lower than examples 1-2. The result of having performed the ****** trial was a nail omission. The gas permeability test result was 0.22m4/sec-kg. As for the drying test result, by the time the moisture content on the basis of the absolute dry condition of a hardening object became 20**2%, it took 20   hours.

[0047]
[The example 5 of a comparison] After mixing for 1 minute at the same temperature as the aluminium powder of the weight section shown in a table 1 as a foaming agent being added after mixing a solid-state raw material and water with the raw material compounding ratio shown in a table 1 and completing mixing, except having slushed into the mold, it produced like examples 1-2, and various physical-properties measurement was performed. The result is shown in a table 2. Specific gravity under oven dry was 0.56. The volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete was 5.3vol(s)% in 200-300 micrometers 2.3vol(s)% at 50-200 micrometers. Also in which hardening object, the strongest line was identified the diffraction (220) line of tobermorite as a result of the powder X diffraction. The result of having performed the ****** trial was cone destruction. The gas permeability test result was 0.14m4/sec-kg. The moisture content on the basis of the absolute dry condition of a hardening object took 35 hours, by the time the drying test result became 20**2%, and   it   was   almost   the   same   as   that   of   an   example   1.   [of   it   ]

[0048]
[The example 6 of a comparison] The PORUTORARUDO cement 31 weight section, the calcined-lime 42 weight section, the fines silica 27 weight section of specific surface area of cement by blaine 11000, and the water 16 weight section were usually mixed at 60 degrees C using the agitator. Then, churning is stopped and put, and it held for 4 hours and was made to harden at 60 degrees C. After mixing the crack object 40 weight section of the acquired hardening object, the ordinary-portland-cement 13.6 weight section, the calcined-lime 13.6 weight section, the fines silica 29.8 weight section of specific surface area of cement by blaine 11000, the gypsum-dihydrate 3 weight section, the water 118 weight section, and the fiber 1 weight section that microfibril-ized recycled pulp, the obtained slurry was slushed into the mold, and where evaporation of moisture is controlled, precure was carried out over 12 hours at 60 degrees C. The precure object was unmolded, the autoclave performed steam curing at 180 degrees C for 4 hours, and the hardening object was acquired. The result of having performed

various physical-properties measurement is shown in a table 2.
[0049] Specific gravity under oven dry was 0.51. Also in which hardening object, the strongest line was identified the diffraction (220) line of tobermorite as a result of the powder X diffraction. The volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete was less than [1vol%] in less than [1vol%] and 200-300 micrometers at 50-200 micrometers. The gas permeability test result was 0.10m4/sec-kg, and was a low value compared with conventional autoclaved lightweight concrete and conventional examples 1 and 2. The drying test result took 85 hours, by the time the moisture content on the basis of the absolute dry condition of a hardening object became 20**2%, and compared with the example 1, the drying time increased it by no less than 65 hours for 50 hours compared with the example 4 of a comparison.
[0050]
[The example 6 of a comparison] 3% of the weight of gypsum dihydrate was mixed with 18 % of the weight of ordinary portland cement, 32.2 % of the weight of calcined lime, 10.7 % of the weight of slaked lime, and 41.7 % of the weight of silica powder of about 20 micrometers of average particles to these sum totals, and water was added and it considered as the slurry so that it might become water / solid-state ratio 0.79 to all solid-state raw materials. JIS which heated this slurry at 40 degrees C, and applied the release agent R It poured into the mold for mortar strength tests of 5201 (10cmx10cmx40cm; reinforcement is not arranged). This mold was set for 10 hours in the ambient atmosphere with a% [of humidity] of 80, and a temperature of 50 degrees C, and precure of the slurry was carried out. After having unmolded the precure object, and the autoclave's having performed steam curing at 180 degrees C for 7 hours and acquiring a hardening object, each physical-properties measurement was performed. The result is shown in a table 2. Specific gravity under oven dry was 0.88. As a result of the powder X diffraction, the diffraction line of clear tobermorite was not observed but the strongest line was a diffraction (101) line of a quartz.
[0051] The volume fraction of the diameter of the maximum air bubbles to autoclaved lightweight concrete was less than [1vol%] in less than [1vol%] and 200-300 micrometers at 50-200 micrometers. The gas permeability test result was 0.10m4/sec-kg, and was a low value compared with conventional autoclaved lightweight concrete and conventional examples 1 and 2. The drying test result took 85 hours, by the time the moisture content on the basis of the absolute dry condition of a hardening object became 20**2%, and compared with the example 1, the drying time increased it by no less than 65 hours for 50 hours compared with the example 4 of a comparison.
[0052]
[A   table   1]

[0053]
[A   table   2]

[0054]
[Effect of the Invention] Since ********, it excels in surface smooth nature, gas permeability can be further held on fixed and the autoclaved lightweight concrete of this invention has light and high compressive strength and the feature that the drying time is short, it is suitable for a wall, a floor, a roof, partition material, etc., and greatly useful on industry.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] Autoclaved lightweight concrete with which there are no air bubbles exceeding an overall diameter of 300 micrometers substantially, a volume fraction of with a 50-micrometer or more overall diameter [200 micrometer or less] air bubbles is less than [more than 20vol%30vol%], a volume fraction of with a 200-micrometer or more overall diameter [300 micrometer or less] air bubbles is less than [more than 2vol%15vol%], and relative bulk density is characterized by or more 0.3 being less than 0.7.
[Claim 2] Autoclaved lightweight concrete according to claim 1 or 2 with which logarithmic distribution width of face in one fourth of height of maximum of differential pore distribution measured with a method of mercury penetration is characterized by or more 0.4 being 1.2 or less.
[Claim 3] An aqueous solution which contains a nature raw material of silicic acid, cement, a calcareous raw material, an aluminum sulfate or its hydrated compound, water, and a frothing agent at least After mixing so that a weight ratio of all used water to AUW of a solid-state raw material may become 2.5 or less [0.9 or more], and obtaining a slurry This slurry is processed in a cellular generator so that unit capacity of a slurry which receives unit capacity of a slurry which does not contain air bubbles after carrying out cellular content may become 1.35 or less times 1.1 or more times. A manufacture method of autoclaved lightweight concrete characterized by carrying out autoclave curing after pouring in and carrying out precure of this cellular content slurry to a mold.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is explanatory drawing of the 4 range-of-prices calculation method [1// of logarithmic] of the differential pore distribution in a method of mercury penetration.

(A): The example of calculation of the logarithmic distribution width of face in one fourth of the height of the maximum for differential pore of an example 1.

(B): The example of calculation of the logarithmic distribution width of face in one fourth of the height of the maximum for differential pore of the example 1 of a comparison.

[Drawing 2] It is explanatory drawing of the calculation method of Ia in a powder X diffraction, and Ib.

(A): The example of calculation of Ia and Ib to an example 1.

(B): The example of calculation of Ia and Ib to the example 1 of a comparison.

[Drawing 3] It is the schematic diagram of the cellular generator used by this invention.

[Translation done.]